Grass and Forage Science

The Journal of the British Grassland Society | The Official Journal of the European Grassland Federation

Ecological characterization of supina bluegrass (*Poa supina* Schrad.) germplasm from the Italian Alps

L. Pecetti*, R. C. Johnson†, M. Romani*, M. Bassignana‡ and G. Della Marianna§

*CRA-Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie, Lodi, Italy, †USDA-ARS Western Regional Plant Introduction Station, Pullman WA, USA, ‡Institut Agricole Régional, Aosta, Italy and §Fondazione Fojanini di Studi Superiori, Sondrio, Italy

Abstract

A collection was carried out in the Italian Alps to gather local genetic resources and acquire information on the ecological adaptation of supina bluegrass (*Poa supina* Schrad.), a cool-season grass native to the Alpine region in Europe. It has potential for pastures and a growing interest for turfs, owing to excellent traffic, shade and cold tolerance. Available germplasm for research and breeding is scant, and extensive collections are needed to enable further development of adapted materials. Alpine germplasm has already proved valuable for breeding at lower altitude in pioneering selection work carried out in Germany. Extensive exploration throughout different environments, mostly above 1600 m elevation, yielded fifty-five novel populations. Collections largely occurred in environments exposed to heavy disturbance by livestock, but it was also frequently found on very poor substrates along mountain paths and dirt roads, or around buildings. Some populations were present locally in shaded environments. Preliminary *ex-situ* observations indicated likely among-population variation to occur for important traits of breeding relevance such as disease and drought tolerance. Genetic variation for adaptive traits, although unproven, is hypothesized given the diversified habitats where the species was collected across the Italian Alps.

Keywords: Alps, high-elevation species, *Poa supina* Schrad., supina bluegrass, turfgrasses

Introduction

Supina bluegrass (*Poa supina* Schrad.) is a perennial, diploid ($2n = 14$), cool-season grass species native to the Alpine region in Europe (Bughrara, 2003). It forms swards of low-medium stature (15–25 cm) and is currently of only moderate interest as a grazing species (Cavallero *et al.*, 2007). On the other hand, the species has a recognized potential as turfgrass, but until recently its use was almost exclusively limited to Germany (Bughrara, 2003). In the last few decades, supina bluegrass has received increased attention in Europe and North America for possible turf utilization. Its stoloniferous habit and outstanding tolerance to traffic and shade (Leinauer *et al.*, 1997) make it a promising species for expanded use in athletic fields, golf courses and home lawns, especially in northern latitudes or under cold conditions (Steinke and Stier, 2003). *P. supina* can also be used for ecological restoration of disturbed areas at high elevation, such as ski runs (Bughrara, 2003; Peratoner, 2003).

Supina bluegrass has often been misclassified as annual bluegrass (*Poa annua* L.) and information on the eco-geography of the two species may be mixed. In their classification of 'pastoral types' [defined as sets of similar facies with 1-(2) dominant species] of Piedmont Alps, Cavallero *et al.* (2007) treated the *P. supina*/*P. annua* type as a continuum, given the resemblance and the possible overlapping of the two species. However, information on collections from the Trentino area indicated that there is very little chance of *P. supina* overlapping with *P. annua* above 1700 m elevation (F. Prosser, pers. comm.). Problems of misclassification can also occur in genebanks (Hughes and Thorogood, 2005). Supina and annual bluegrasses do actually share common features, such as low growth and smooth, light-green foliage, as well as some preference for common habitats. Nonetheless, and apart from a difference in ploidy (*P. annua* mostly being an allotetraploid with $2n = 4x = 28$), differences exist that enable a satisfactory distinction between the two taxa as described below and by Pietsch (1989), Heide (2001) and Dietl *et al.* (2005).

The available genetic resources of supina bluegrass for research and breeding are very limited. Most of the

Correspondence to: L. Pecetti, CRA-Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie, Lodi, Italy.
E-mail: luciano.pecetti@entecra.it

Received 15 February 2010; revised 19 August 2010

   doi: 10.1111/j.1365-2494.2010.00766.x

studies on this species were carried out on just two related cultivars, 'Supra' and 'Supranova', which were selected at low altitude in Germany from Alpine germplasm (Bughrara, 2003). Accessions held in European collections number <10 (Weise *et al.*, 2007), and the National Plant Germplasm System of the USA has no accessions of *P. supina* available. Lack of germplasm hinders the full realization of the species' potential, and a comprehensive collection could reveal useful diversity for basic attributes such as resistance to biotic stresses, shade, drought and seed production, thus supporting the development of adapted materials. This note summarizes the main achievements of a mission carried out in the Italian Alps to enlarge the gene pool for further research and germplasm development and to acquire information on the ecological adaptation of supina bluegrass.

Materials and methods

Available information (Pignatti, 1982; Cavallero *et al.*, 2007) suggested that *P. supina* occurs across the Italian Alps in the altitude belt between about 1500 and 2800 m above sea level (a.s.l.). Local knowledge by Alpine botanists/agronomists was also important to define the main routes of the collection. In 2007, 1 year prior to the collecting trip, preliminary exploration in different Alpine areas was completed for a better understanding of possible environments of occurrence of the species. The collecting mission took place during the last week of June and the first week of July 2008 in high-elevation environments in different districts of the north-east, central and north-west Alps. We chose this period, prior to the arrival of livestock to summer pastures, as it would be more difficult to detect the species on grazed swards. This period, however, was also often before the development of mature seeds. In the absence of seeds, vegetative plants were collected from a given population by coring several small sod samples along transects intersecting all apparent niches in the collection site. Otherwise, mature seeds were hand-harvested by adopting the same sampling criteria.

As many sites as possible were collected within a given valley/area and different environments were explored to detect the species, such as edges of dirt roads, footpaths, ski infrastructures and slopes, isolated buildings (of rural use or not), ungrazed (unused or mown) grasslands, grazed grasslands, high-altitude livestock rearing infrastructures. Detection of *P. supina* spots was aided, even within grass associations, by its evident light-green foliage colour.

Although the collection was mostly carried out at altitudes where the chance of sympatry of *P. supina* and *P. annua* was low, all care was taken to avoid confounding the two species to ensure only *P. supina* was collected. The most easily detectable morphological differences were the much shorter ligule at the base of the leaf blade and the stoloniferous habit (sometimes with adventitious rooting from the nodes) of *P. supina*. To distinguish the species, no use was made of less evident morphological features, such as anther length (Dietl *et al.*, 2005), or complex laboratory tests, such as flow cytometry (Hughes and Thorogood, 2005).

The nearest collection sites within the same valley/area were at least a few hundred meters apart, so as to avoid possible overlapping of population sampling, but in most cases, the nearest sites within a given valley/area were a few kilometres apart. Although gene flow between collection sites cannot be entirely excluded (Huff, 2010), full self-fertilization of *P. supina* is the expected norm (Bughrara, 2003).

When a supina bluegrass population was detected, environmental information at the collection site was recorded. Latitude, longitude and altitude were obtained with a GPS device and aspect by a compass. Topography, habitat and soil type/texture of the site were recorded based on discrete classes. The observed frequency distribution of each feature was compared with the expected frequency of equally random distribution among classes. The Fisher's exact test was used because of the possible occurrence of classes with frequency <5 that would hinder the application of the common chi-square test.

Grown for 4 weeks in plastic trays to favour recovery from the sampling and to encourage plant rooting, sods of vegetatively collected populations were field transplanted for seed multiplication in the mountain site of Cepina, Rhaetian Alps (1200 m a.s.l.; average annual rainfall: 736 mm; average May–October rainfall: 536 mm; average daily mean temperature of the coldest month: −1·3°C; average daily mean temperature of the May–October period: 13·6°C) in plots of about 1 m × 1 m (one plot per population) grown in a level field with sandy soil and 7·6 pH. The outbreak of natural epiphytotics of rust (*Puccinia* sp.) in September enabled a preliminary assessment of germplasm reaction to the disease on a zero (no symptoms) to five (more than 50% affected leaf area) scale. Spare sods of twenty-one populations were also transplanted in a lowland site of northern Italy (Lodi, 81 m a.s.l.) with moderate summer drought stress. During summer 2009 (147 mm total June–August rainfall; 31·4°C average maximum daily temperature in the same period), minimal irrigation was provided (about 90 mm), well below the optimal level for any turf, to make preliminary observations of population behaviour.

Results and discussion

Altogether, fifty-five populations of *P. supina* were collected in the Italian Alps, of which seventeen were from the north-east Alps, seven from the central Alps and thirty-one from the north-west Alps (Table 1). The different numbers from the three Alpine sectors did not necessarily reflect differences in the species' occurrence, but were likely related to the depth of exploration in a given district, depending on the ease of approaching the environments of interest. All the explored valleys and areas yielded at least two populations (Table 1).

For the reason explained above, most collections (39 of 55) were vegetative. Mature seeds were present and could be harvested from only sixteen of the fifty-five collection sites. Vegetative samples outnumbered seed samples in the north-east and north-west Alps, but not in the central Alps. Most of the collection sites were between 1800 and 2100 m a.s.l., with a mean altitude of 1964 m a.s.l. (Figure 1a). The altitude extremes of collection sites were 1290 and 2539 m a.s.l., both being recorded in the same valley (Val d'Ayas). The 1290 m collection site represented a possible outlier in the overall distribution of collection sites, falling below the first quartile by more than 1·5 times the interquartile range (Figure 1a). A comparison of the distribution of collection sites yielding either vegetative samples (Figure 1b) or mature seed samples (Figure 1c) showed that the latter occurred, as expected, at lower altitudes, being mostly located between 1600 and 1900 m a.s.l. with a mean altitude of 1759 m a.s.l., whereas the former occurred mostly between 1850 and 2100 m a.s.l. with a mean altitude of 2048 m a.s.l. The altitude range of detection throughout the Italian Alps confirmed previous information (Pignatti, 1982).

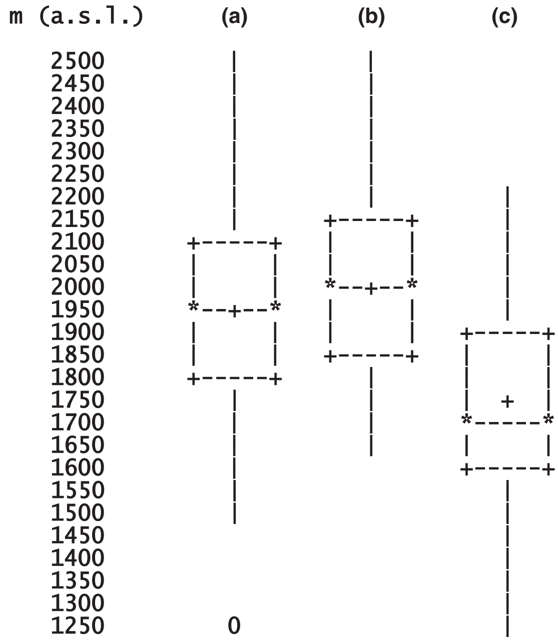

Figure 1 Box plot of altitude of collection sites of supina bluegrass populations collected in the Italian Alps: (a) All fifty-five collected populations; (b) thirty-nine populations for which a vegetative sample only was collected; (c) sixteen populations for which a seed sample was collected. + - - - - - - - +: sample lowest (25th) and highest (75th) percentile; *- - - - - - -*: sample median; +: sample mean; vertical bars: sample minimum and maximum within a distance of 1·5 interquartile range; 0: value beyond the limit of 1·5 interquartile range.

Table 1 Summary of the collection of supina bluegrass (*Poa supina* Schrad.) carried out in the Italian Alps.

Sector	Alp section	Administrative region	Valley/area explored	No. of collected populations
North-east Alps	Dolomites; Venetian Prealps	Province of Trento; Province of Bolzano; Veneto	Val di Fiemme	3
			Val di Fassa	4
			Sella Massif	8
			Asiago Plateau	2
			Subtotal	17
Central Alps	Rhaetian; Orobic	Lombardy	Valmalenco	2
			Val Fontana	2
			Val Brembana	3
			Subtotal	7
North-west Alps	Lepontine; Pennine; Graian; Cottian	Piedmont; Valle d'Aosta	Val Formazza	5
			Val d'Ayas	9
			Valle di Ollomont	6
			Valle del Gran S. Bernardo	3
			Valle di La Thuile	6
			Val Maira	2
			Subtotal	31
			Total	55

Frequency of collection sites was little influenced by topography (Fisher's exact test not significant, $P > 0{\cdot}05$), although a great proportion of sites did not exceed a 8% slope (Table 2).

The great majority of collection sites (65·5%) were in disturbed habitats, while grasslands represented about one-third (29·1%) of sites and only very few populations were collected along field margins (Table 2). The only population collected in a garden (at the margin of a lawn) was the one found at the lowest elevation (1290 m a.s.l.). The null hypothesis of random distribution of collection sites among habitats was rejected by Fisher's exact test ($P < 0{\cdot}001$). When the collection sites in disturbed habitats were further subdivided, it was found that about half (47·2%) of them were near high-elevation livestock operational areas, 38·9% were located along mountain paths/roads, and the remnant 13·9% were near other buildings, such as old hay shacks (Table 2). Some of the latter populations were noticeable for growing in the shaded sides of the buildings.

The species proved to thrive in higher-elevation environments where cattle are typically moved for summer pasture from lower-altitude sites. These environments include pasture areas grazed from late June to September and a series of centralized buildings for sheltering the animals at night and other operations, such as milking and cheese curing. *P. supina* can be a dominant species especially in the areas of animal rest and handling, subjected to trampling and dung concentration. The habitat preference of supina bluegrass observed in the Italian Alps is also reflected by one of its German common names, namely 'Lägerrispe', meaning 'bluegrass where cows lay' (Leinauer, 1998).

More than half of the collected populations (56·4%) grew on stony or gravel substrates (Table 2). This was because of the frequent finding of supina bluegrass along paths/roads or around buildings where the natural substrate was often consolidated by a layer of gravel to facilitate operations and traffic. Another 25·4% of populations were found on light-textured soils (sandy and sandy loam), 7·3% on loam soils and 10·9% on heavy-textured soils (clay loam and clay). The Fisher's exact test rejected the null hypothesis of random distribution of collection sites among soil types ($P < 0{\cdot}05$).

Although certainly not exhaustive, the collection was likely fairly representative of supina bluegrass environments in the Italian Alps. Previous indications on the adaptation of the species to trampled and eutrophic spots caused by the presence of livestock were fully confirmed (Pignatti, 1982; Cavallero *et al.*, 2007). In addition, the occurrence of supina bluegrass on disturbed areas with much poorer substrates suggested local adaptation to additional high stress environments.

After the ongoing phase of seed multiplication, a remarkable collection of supina bluegrass will be made available for research and breeding purposes. The frequent occurrence of the species in difficult environments points to specific adaptation features that it may display if exploited for turf purposes. The collected germplasm is likely to widen the genetic basis of supina bluegrass in the breeding activity without worsening acknowledged features such as its wear or shade tolerances. The fact that the milestone German varieties 'Supra' and 'Supranova' were selected at a low-altitude site from Alpine ecotypes points to the possibility that the usefulness of germplasm from the Alps is not necessarily restricted to mountain areas.

Further evaluation is needed to test whether differences in growth and adaptation do exist among-populations in relation to different geographical provenance and ecological niches. Preliminary *ex-situ* screening for rust susceptibility in Cepina indicated that germplasm variation may be found for disease tolerance, as populations from the central and north-east Alps were less affected by rust than those from the north-west Alps (mean score of 0·75, 0·69 and 2·52 for the three

Table 2 Ecological characterization of collection sites of supina bluegrass (*Poa supina* Schrad.) populations from the Italian Alps.

Class frequency (%)					
Topography		**Habitat**		**Soil type/texture**	
Level (0–3%)	27·3	Grassland	29·1	Stony	29·1
Undulating (3–8%)	36·3	Field margin	3·6	Gravel	27·3
Gently rolling (8–16%)	20·0	Garden/orchard	1·8	Sandy	10·9
Sloping (16–30%)	16·4	Disturbed habitat:	65·5	Sandy loam	14·5
P Fisher's exact test*	>0·05	Along paths/roads	38·9	Loam	7·3
		In livestock operational areas	47·2	Clay loam	9·1
		Near other buildings	13·9	Clay	1·8
		P Fisher's exact test*	<0·001	*P* Fisher's exact test*	<0·05

*Comparing the observed frequency distribution with the expected frequency of equally random distribution among classes.

areas, respectively, on the adopted 0–5 scale). Similarly, in the preliminary screening for summer stress in Lodi, three populations of twenty-one had outstanding survival, highlighting that variation may also occur in the species for drought and heat tolerance. Although unproven at this stage, genetic variation for adaptive traits is hypothesized given the diversified habitats of *P. supina* collection sites across the Italian Alps.

Acknowledgments

The work was carried out within the USDA-ARS-funded project 'Plant exploration in Europe to collect *Poa* species for crop improvement', implemented through the WRPIS, Pullman WA, USA, in collaboration with CRA-FLC, Lodi, Italy. Dr F. Prosser, Civic Museum of Rovereto, is gratefully acknowledged for useful information on the localization of the species in the Alpine region.

References

Bughrara S. (2003) Supina bluegrass. In: Casler M.D. and Duncan R.R. (eds) *Turfgrass biology, genetics, and breeding*, pp. 53–59. Hoboken, NJ, USA: John Wiley & Sons.

Cavallero A., Aceto P., Gorlier A., Lombardi G., Lonati M., Martinasso B. and Tagliatori C. (2007) *I Tipi Pastorali delle Alpi Piemontesi*. Bologna, Italy: Alberto Perdisa Editore.

Dietl W., Lehmann J. and Jorquera M. (2005) *Le graminacee prative*. Bologna, Italy: Pàtron Editore.

Heide O.M. (2001) Flowering responses of contrasting ecotypes of *Poa annua* and their putative ancestors *Poa infirma* and *Poa supina*. *Annals of Botany*, **87**, 795–804.

Huff D.R. (2010) Bluegrasses. In: Boller B., Posselt U.K. and Veronesi F. (eds) *Fodder crops and amenity grasses. Handbook of plant breeding 5*, pp. 345–379. New York, USA: Springer.

Hughes S.J. and Thorogood D. (2005) Distinguishing *Poa supina* and *P. annua* by species specific isozyme alleles and flow cytometry. *International Turfgrass Society Research Journal*, **10**, 654–660.

Leinauer B. (1998) *Poa supina* on both sides of the pond: the European perspective. IN: *68th Annual Michigan Turfgrass Conference Proceedings*. Volume 27, pp. 184–186. Lansing, MI, USA: Michigan State University Extension.

Leinauer B., Schulz H., Bar D. and Huber A. (1997) *Poa supina* Schrad.: a new species for turf. *International Turfgrass Society Research Journal*, **8**, 345–351.

Peratoner G. (2003) *Organic seed propagation of alpine species and their use in ecological restoration of ski runs in mountain regions*. Kassel, Germany: Kassel University Press GmbH.

Pietsch R. (1989) *Poa supina* (Schrad.) und seine Bedeutung für Sport- und Gebrauschsrasen [*Poa supina* (Schrad.) and its value for sport and amenity turf]. *Zeitschrift für Vegetationstechnik*, **12**, 21–24.

Pignatti S. (1982) *Flora d'Italia (3 Vol.)*. Bologna, Italy: Edagricole.

Steinke J. and Stier J.C. (2003) Nitrogen selection and growth regulator applications for improving shaded turf performance. *Crop Science*, **43**, 1399–1406.

Weise S., Harrer S., Grosse I., Knüpffer H. and Willner E. (2007) The European *Poa* Database (EPDB). *Plant Genetic Resources Newsletter*, **150**, 64–70.